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A DANGER FOR OUR IRON SHIPS.

Not long since were lost two of the best steamships ever floated, the *Atlantic* and the *City of Washington*; and not only is their loss a serious public calamity, but it places before the scientist a point requiring his unremitting attention. Of the cause of the loss of one of these vessels, it is so far certain that the navigating officer was misled by a deviation from the true line of the ship's compass needle. Placing the usual implicit trust in the magnetic needle, the captain steered his vessel not to her destination, but to destruction. The disturbing cause, affecting the truth of the compass, is said to be the load of iron, steel, and tin in the ship's hold; and how many ships put to sea, built of iron, or with cargoes of iron, that are open to the same cause of error, accident, or destruction.

But it should be known that this source of danger is not unprovided for; that, on the contrary, the greatest care is taken, in the case of an iron ship, to detect and compensate for this error. For determining the deviation due to the ferruginous material employed in their construction, iron vessels are "swung" in different directions; and the variation is noted between the indications of a standard compass placed in as nearly neutral situation as can be found—that is, at a point where the local attractions are evenly balanced—and the indications of the binnacle or ship's compass. A table is constructed upon the data afforded by these variations, and by this table is regulated the course of the ship when lunar or solar observations cannot be taken. But great as the care that may be taken in the calculation of the table—and the care taken by our naval architects and builders is exceedingly great—such care may in a moment be rendered valueless, for the vessel may acquire a new magnetic polarity very different from that with which she left the dock.

We know that magnets are of two kinds, permanent and induced. The needle of the compass is a permanent magnet. It is also known to scientists that a shell or iron bar laid in the magnetic meridian—north and south—will become temporarily a magnet; and that if struck or smartly jarred whilst in this position, that the bar will acquire a certain magnetic polarity quite sufficient to affect the ordinary compass needle. What of this? Why, an iron ship is but a big bar of iron, which, if running north and south, may be rendered permanently magnetic by the percussion of the waves against its sides, or even by the sharp strokes of the working of its own engines in a storm. Instances far too numerous are on record of the truth of this theory. The *Tiber* and the *Snowdon* both lost, or had their magnetic polarity reversed by the sharp blow of a minor collision. The *Aphrodita*, with a known deviation of her compass needle of 21° 30′, ran against a pier, and the deviation was lessened by four degrees, showing that in an iron vessel the time when most is required from the compass—perhaps in the dark, when a vessel has struck—that instrument is useless. As to iron cargoes, it has been known that an iron ventilating shaft, placed near the standard compass, has quite misled the navigator. Many methods have been proposed in reference to the remedy of this defect. The latest, perhaps, is that of M. Glösener, who suggests "the placing of the standard compass out upon the bowsprit, at a distance previously determined to be without the sphere of attraction of the iron in the vessel. By this means, instead of the attracting substances being grouped around the instrument, perhaps unequally, they necessarily are all upon one side of the compass, and symmetrically placed in regard to it. The latter is, of course, so fixed, that the lubbers point and the foot of the needle pivot are in a line parallel to the longitudinal axis of the ship. To reflect a portion of the card, an inclined mirror is arranged above it, in which the indication is read from the deck by means of a glass." But some of our iron ships are constructed without bowsprits, even if the method were a reliable one, so that the subject still calls for the earnest attention of our scientific men. For the study of the subject means the saving of valuable property, nay, the saving of innumerable invaluable lives.

DUPLEX TELEGRAPHY.

By W. H. PREECE, Memb. Inst. C.E. and Soc. T.E.

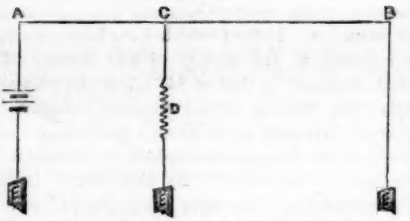
(Continued from page 247).

3. *Leakage.*—It now remains for me to explain the third method of duplex working, which has been adopted practically, and which is less known than any of the other methods because it has not been published before this, although it was worked experimentally, in the year 1856, between Southampton and Cowes. Our busy practical engineers have, as a rule, so much work to do, that they have no time to write and publish accounts of all the trials and experiments upon novel plans and new apparatus which they make, especially when their results are not entirely successful. Consequently

many new kinds of apparatus, modes of working, systems, and plans which have been thoroughly thrashed out, are, years after, brought out as new inventions, for the want of this publication. Duplex telegraphy was thoroughly exhausted in 1856, and with our then means it proved a failure. It has now, thanks to Mr. Stearns and to our improved means, proved a success, not, however, so much by the reproduction of exploded plans as by the introduction of methods which are as novel as they are ingenious, and which I shall shortly explain. I never published the leakage plan, as much from want of opportunity as from want of real practical success with our then means. It is now thoroughly practical and in use.

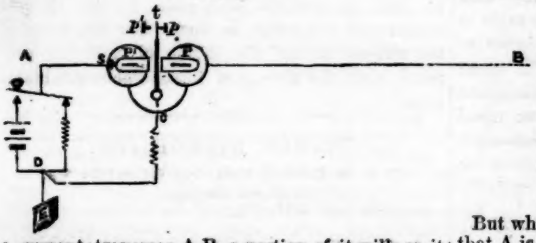
The *leakage* principle, unlike the differential or the bridge, is dependent upon the *inequality* of a current in different portions of its path. If a wire extend from A to B (Fig. 14), and it be perfectly

Fig. 14.



insulated throughout its whole length, and a current be established through it, we know that the current in every point of its circuit has precisely the same strength. If, however, the wire be imperfectly insulated, leakage will occur along its length, and the portion of the current arriving at B will be so much the weaker than that leaving A the greater the loss which it sustains along the wire. Let us for the present assume the line A B to be perfectly insulated, and at the point C an artificial resistance to be connected with the earth, causing a leakage or partial earth at that point,—then when

Fig. 15.



a current traverses A B, a portion of it will, as it were, be abstracted at the point C and will flow to earth through the derived circuit, C D. The current in A C will, therefore, be stronger than that in C B. The strengths of the currents passing through C B and C D will be to each other inversely as their resistances, and the sum of the two currents will be equal to that flowing through A C. Let us, for the sake of simplicity, assume that the resistance of the leakage, C D, is equal to the rest of the line C B, then the current flowing through each will be equal, and they will together be equal to that flowing through A C. Hence, under these conditions, the current in A C has twice the strength of that in C B.

Now, taking the first case, where there is no leakage at all, and allowing the current in A C (Fig. 15), to traverse one coil, P, of an ordinary polarised relay, in such a way that it causes the tongue (*t*) at the relay to come into contact with the point *p*, and to traverse the other coil, P', in such a way as to cause the tongue to come into contact with the other point, *p'*, then, since the same current traverses the two coils in opposite directions under similar conditions, the effect upon the tongue of the relay will be nothing. If, now, at the point C, between these two coils, we insert the leakage, C D, equal in resistance to the rest of the circuit, C B, the current passing through the coil P will be twice the strength of that passing through the coil P'; it will therefore preponderate, and the tongue of the relay will be moved into contact with the point *p*. If, now, the pole piece of the iron core of the coil P be moved away, by means of an adjusting screw *s*, from the tongue *t*, until it is about twice as far off as that of P', its influence upon the tongue will be the same, and the preponderating influence of the current in A C over that in C B will be destroyed, and therefore the relay will not be affected. Consequently currents can be sent from A to the distant point B without disturbing its own relay. Hence, while A alone is sending messages to B, its own apparatus is not affected, and we have the first condition of duplex working.

Now how is the relay at A affected by currents received from B? Assuming in the first instance the existence of no leakage at C, but the adjustments otherwise arranged for duplex working, the current passes first through P', and then through P, but its influence through P is only half that through P', because of the distance of the pole piece from the tongue at the relay; hence the current through P' will preponderate over that in P, and the received currents will affect the relay. But, if now, in addition to this, we introduce a leakage at C, it will abstract from the current coming from B a portion of its strength, so that the current in C A is weaker than that in B C, and thus its influence on P is still further reduced. In fact its influence though P may practically be said to be nothing. Hence all received currents operating through P' work the relay at A to register signals and record messages. Thus, when A is working to B alone, or B working to A alone, its own apparatus is not affected, and marks are duly recorded at B or A as the case may be.

But when B is sending to A at the same time that A is sending to B, what happens? The current through P' at A is weakened by an amount exactly equal to the strength of the current received from B, equality of influence on the tongue of the relay is disturbed, and the preponderance of the current in P over that in P' is produced to move the tongue of the relay; marks continue to be made, and to be made with precisely the same strength whether the stations be working simultaneously or separately. It is evident that whatever conditions exist to produce a current through P' and P, when B alone is sending, the same conditions exist when A is

simultaneously sending, and their tendency must be to weaken the currents sent from A to precisely the same amount. Hence the preponderance of the current in P over that in P' must be exactly equivalent to the received current from B when working separately. Thus, while A is sending messages to B, B can send messages to A upon the same wire and at the same time.

We assumed the line A B to be perfectly insulated throughout its length, but it is now evident that the condition of the line between P' and B is immaterial, and that it is the relative strength of the currents in P and P' alone that determine the problem. Of course these coils must be perfectly insulated. Again we assumed that the resistance of the derived circuit C D to be the same as that of C B, but this is by no means material, and was only done for simplicity. The smaller the resistance at C D, compared with that of C B, the greater the difference at the currents in P and P'. If there be no resistance whatever in C D, all the received currents would pass through P' only. Similarly, all the currents from A would pass through P only. If the resistance of C D be infinite, we could not work duplex, because we could not produce equilibrium. Hence the resistance of C D must be adjusted between these two extremes to produce the best effect. But we have not considered the resistance at the branch A E. It must not be small, otherwise the weakening effect of the leak on the received current is not great, since it depends solely on the relative resistances of the two branches A E and C D; and it must at least be equal to the resistance of the battery, otherwise the equilibrium of the circuit is disturbed when sending and receiving. The maximum effect is produced when the resistance of the three branches are equal to each other.

This method, unlike that at the bridge, is not independent of the character of the apparatus used for receiving messages. It requires the use of a polarised relay, with an adjustable pole piece, or coils constructed on similar principles. Double relays have been specially constructed to work it so as not to reduce the working strength of the received currents, which must necessarily be the case when only one coil of an electro-magnet is used, but I shall have to refer to them when dealing with another portion of the subject. I have up to the present simply dealt with the theoretical method of working duplex telegraphy, without reference to the special instruments employed, or to the disturbing influences practically introduced in working telegraphs.

The leakage plan remedies all the defects pointed out as inherent to Gintl's original solution of the problem.

1. The circuit is never broken, for it is permanently connected to earth at C.

2. There is only *one* battery and *one* current.

3. The resistances of the apparatus are constant, but though the resistance of the external circuit or line wire must vary with the vicissitudes of the weather, its variation affects both sides of the equilibrating arrangement, though not equally, because C D does not vary. Hence this system is unique in this respect, that both the compensation and working arrangement are affected by the variations in the resistance of the line. If they were equally affected, duplex workings would be simplicity itself. This is a problem in duplex telegraphy which remains to be solved.

(To be continued).

MATHEMATICS FOR NON-MATHEMATICIANS.

By WILLIAM PAGET HIGGS, LL.D., D.Sc.

Division I.—The Algebra of Constant Quantities.

(Continued from p. 265.)

Compound Multiplication and the Binomial Theorem.

The reader will have seen that the repeated addition of a quantity to itself is termed multiplication. To illustrate this familiarly, let us understand by the letter a the possession of one apple. Then it will be perceived that multiplication by 1 or $1a$, or once a is equal to a, showing that the coefficient 1 need not be written. Indeed 1 as a coefficient is always omitted. But multiplying a by 2 is to take two apples, $a + a$; and so on. In cases of numerical coefficients of higher value than 1 or unity, the coefficient cannot be omitted.

To multiply by a fraction, it must follow, is to take a certain portion of the quantity multiplied. The multiplication of a by $\frac{1}{2}$ is represented by taking half-an-apple; the multiplication of $4a$ by $\frac{1}{2}$ by taking 2 apples from 4.

Whilst the multiplication of a whole quantity, therefore, by a quantity greater than unity, results in a product *greater* than the quantity multiplied; the multiplication of a whole quantity by a fractional quantity results in a product *less* than the quantity multiplied. For the want of this, or similar axiomatic reasoning, the student is often, for a moment, confused, when he finds that the result of *multiplication* is a lesser quantity than the quantity multiplied.

He will now see that, as the value of the multiplier is gradually reduced, so is reduced the value of the product; and when the value of the multiplier equals 0, the product will be 0. Thus $a \times 0 = 0$; and equally $a \times b \times c \times 0 = 0$; so that where 0 enters as a factor, the product is 0.

To multiply together fractions, is to take a part or parts of the part or parts of a quantity. To multiply $\frac{1}{4}a$ by $\frac{1}{2}$ is represented by taking one fourth of half-an-apple, giving the product of one-eighth of an apple, or $\frac{1}{8}a$. Had it been required to multiply $\frac{1}{4}a$ by $\frac{3}{4}$, the process would be represented by taking half-an-apple, dividing this half into three parts, and taking two of these parts, or two-sixths of the entire apple, $\frac{2}{6}a$. This reasoning, which it will be necessary to resume in the consideration of fractional quantities, is too closely consequent upon the previous study of multiplication to be here omitted; and the reader who wishes a more extended practice in mathematics than these present pages are intended to convey, will do well to make himself familiar with the instances given by substituting other quantities.

Although it is not productive of difference in the results of multiplication, the arrangement of literal coefficients generally follows alphabetical order. Let $a=4$ and $b=5$; the result of the operation indicated by $a \times b$, $a \cdot b$, or ab—and by $b \times a$, $b \cdot a$, or

ba, namely that of multiplying in the one case a by b, and in the other b by a—is the same.

The multiplication of compound quantities is perhaps best considered from the view-point of multiplying, say, $4a$ by $5b$. The operation indicated is that of taking $4a$, $5b$ times, or $5b$ $4a$ times. If we commence by taking $5b$ a times, we have the result $5ab$. This result is to be taken 4 times, to give the final result of 20 ab.

Thus we have the general rules:—

1. That when factors are multiplied, the order of their multiplication is without effect upon the product.

2. That if the factors are compound quantities, each term of one factor must be multiplied into each term of the other factor,

A *compound* quantity is, however, generally understood to consist of two or more quantities connected by the signs of *plus* (+) or *minus* (−). $a+x$ is thus a compound quantity, and ax a simple quantity, because in the latter case the signs of + and − do not exist.

The members which compose a compound quantity (for instance the a or the x in the compound expression $a+x$) are called *terms*; and a quantity of—

two terms is known as a binomial.
three „ „ „ „ trinomial.
four „ „ „ „ quadrinomial.
etc.

The distinction between simple and compound quantities is one of great importance, and is founded on the following principle. Let it be required to multiply $a\times b\times c\times x\times n$ by n; the product is—

$$a\times b\times c\times x\times n\text{; or—}$$
$$abcnx.$$

But if the quantity to be multiplied by n were $a+b+c+x$, the product would be—

$$na+nb+nc+nx.$$

Hence rule 2. In the first instance we multiply a product by n; in the second we multiply each of the terms of a sum. If figures are substituted for letters, the difference is at once evident; thus in the first instance—

$$\begin{array}{ccccccccc} a & \times & b & \times & c & \times & x & \times & n. \\ \| & & \| & & \| & & \| & & \| \\ 1 & \times & 2 & \times & 3 & \times & 4 & \times & 5 = 120. \end{array}$$

In the second—

$$\begin{array}{ccccccc} na & + & nb & + & nc & + & nx. \\ \| & & \| & & \| & & \| \\ 1\times5 & + & 2\times5 & + & 3\times5 & + & 4\times5 = 50. \end{array}$$

In the second instance the quantity $a+b+c+x$ is compound, and the quantity n simple. The next step to consider will be the multiplication of factors, both compound. For example, let it be required to multiply $a+b$ by $c+x$. The operation to be performed is to multiply $c+x$ by a and by b, and to take the sum of the products. $c+x$ multiplied by a gives $ac+ax$; and $c+x$ multiplied by b gives $bc+bx$; adding we have the final product $ac+ax+bc+bx$.

Before we proceed to Newton's great discovery—the Binomial theorem—it will aid us to recur to the principle that regulates the signs of the quantities of the product. Multiplication considered as the process of repeated addition affords easy verification of the rule that the multiplication of quantities with like signs gives plus, and with unlike signs minus, quantities. Thus x or $+x$ multiplied by -3 is represented on the principle of addition by $+x+x+x$, *subtracted* from the other quantities (if any) with which the quantity x may be allied, and is consequently $-3x$. That is we are to subtract three times x. The distinction, then, between multiplying by a positive and by a negative factor, is that the sum of the repeated addition is, in the case of positive signs, to be added to the other terms (if any); or, in the case of negative signs, to be subtracted from the other terms (if any). If there are no other terms, the product stands alone; in the case of the product of unlike signs, the negative sign is prefixed.

To illustrate this, let us multiply $a+b$ by $a+b$; $a+b$ by $a-b$; and $a-b$ by $a-b$.

$$\begin{array}{r} a+b \\ a+b \\ \hline aa+ab \\ \quad +ab+bb \\ \hline aa+2\,ab+bb\text{; or } a^2+2ab+b^2. \end{array}$$

From this we learn that $a+b$ multiplied into itself, or squared, gives as product the sum of the squares of the two terms *plus* twice their product.

$$\begin{array}{r} a-b \\ a+b \\ \hline aa-ab \\ \quad +ab-bb \\ \hline aa \quad -bb\text{; or } a^2-b^2. \end{array}$$

$$\begin{array}{r} a-b \\ a-b \\ \hline aa-ab \\ \quad -ab+bb \\ \hline aa-2ab+bb=a^2+b^2-2ab. \end{array}$$

And from the last calculation we see that the square of the difference of a and b (and what is true of a and b should be true of all quantities) is equal to the sum of the squares of the two terms *less* twice their product.

We are now in a position to understand the method of the Binomial theorem.

The Binomial Theorem.

So important is thought by mathematicians the method of the Binomial theorem, that the discovery is recorded upon the tomb of its inventor, Sir Isaac Newton. The reader will at once perceive the value of the invention when he is told that the binomial theorem admits of the immediate involution of binomial quantities to any proposed power. The involution of $(a+b)$ to so low a power as the fourth entails by the ordinary process of multiplication considerable labour; but to involve a high power would need days or even weeks of labour, liable at all times to error. By the binomial theorem the involution may be effected almost at sight.

Let us commence investigation of the method by involving $a+b$ to the second, third, and fourth powers—

$$(a+b)^2=a^2+2ab+b^2.$$
$$(a+b)^3=a^3+3a^2b+3ab^2+b^3.$$
$$(a+b)^4=a^4+4a^3b+6a^2b^2+4ab^3+b^4.$$

And—

$$(a-b)^2=a^2-2ab+b^2.$$
$$(a-b)^3=a^3-3a^2b+3ab^2-b^3.$$
$$(a-b)^4=a^4-4a^3b+6a^2b^2-4ab^3+b^4.$$

Study of these tabulated results of involution will lead us to the principles by which we may write down the power of any binomial.

First, we perceive that the number of terms is always one greater than the power required.

Secondly, if both terms of the binomial are positive, all the quantities remain positive; but that a residual* binomial has its odd terms (counting from the left) positive, and its even terms negative.

Third. The exponent of the first or *leading* quantity (a) is always the index of the required power; and the powers of this quantity decrease by 1 in each successive term. The index of the second term of the quantity to be involved (b) (called the *following* quantity), begins with 1 in the second term, and increases by 1 in each successive term until it equals the required power.

Fourth. The coefficient of the first and last terms is always 1. The coefficient of any term multiplied by the index of the first letter (leading quantity) in that term, and divided by the index of the second letter (following quantity) increased by 1 gives the coefficient of the next succeeding term. The coefficient of the second, and next to the last terms, is the index of the required power.

The algebraic formulation of the theorem is—

$$(a+b)^n = a^n + n\,a^{n-1}b + n.\frac{n-1}{2}\,a^{n-2}b^2 + n.\frac{n-1}{2}.\frac{n-2}{3}\,a^{n-3}b^3 + \&c.$$

By the substitution of the letters, A, B, C, for the coefficients—

$$n,\ n.\frac{n-1}{2},\ n.\frac{n-1}{2}.\frac{n-2}{3},\ \&c.$$

the formula is much simplified, and becomes

$$(a+b)^n = a^n + \mathrm{A}\,a^{n-1}b + \mathrm{B}\,a^{n-2}b_2 + \mathrm{C}\,a^{n-3}b^3,\ \&c.$$

Let us now endeavour, by following the foregoing rules, to raise $a+b$ to the sixth power. By the first principle, the number of terms will be 7. The signs will be plus.

The indices of the 7 terms will be a^6, a^5b, a^4b^2, a^3b^3, a^2b^4, ab^5, b^6.

The coefficients will be—

$$1,\ 6,\ \frac{6\times5}{2},\ \frac{15\times4}{2},\ \frac{20\times3}{4},\ 6,\ 1.$$

Collecting these steps, we have the complete expression—

$$a^6+6a^5b+15a^4b^2+20a^3b^3+15a^2b^4+6ab^5+b^6.$$

By substitution other binomials may be reduced to the form $(a+b)^n$. Thus, if the 6th power of $(3d+2e)$ were required, the result could be obtained by substituting a for $3d$ and b for $2e$. Then, raising $a+b$ to the 6th power, as given above, we afterwards obtain, by restoring the values of a and b, the expression—

$$729d^6+2916d^5e+4860d^4e^2+4320d^3e^3+2160d^2e^4+576de^5+64e^6.$$

Or it may occur that one of the terms of the binomial is a unit, as $(a+1)^3$. In this case, since every power of 1 is 1, and multiplication by 1 is unproductive of alteration in the product, the unit is usually omitted, except in its essential place, the first or last term.

For example—

$$(a+1)^3 = a^3+3a^2+3a+1;$$

and—

$$(1+a)^n = 1+nx+n.\frac{n-1}{2}\,x^2+,\ \&c.$$

By similar tact in dealing with problems, the binomial theorem may be made to include the involution of quantities of more than two terms. In the event, also, of one of the terms of a binomial being a fraction, as $(a+\frac{1}{2})^3$, tact affords a far better method than rule in solving the question. Thus, $a+\frac{1}{2}$ may be written $\frac{2a+1}{2}$, and

$$\left(\frac{2a+1}{2}\right)^3 = \frac{4a^3+4a+1}{4} = a^3+a+\tfrac{1}{4}.$$

* A residual quantity expresses the difference of two quantities, as $a-b$.

LIGHTNING AND LIGHTNING-RODS.*

By JOHN M. MOTT

LIGHTNING is atmospheric electricity moving through bad conducting matter under an explosive form.

A lightning-rod is a conductor of electricity so applied to an object as to prevent the accumulation of free electricity upon it, by induction, and also to enable it to transmit, in safety, the electric force by which it may be assailed.

The construction and application of lighting rods has appeared to most persons a matter too simple to need aid from scientific minds, while not a few have looked upon the whole theory as absurd, and as a source of danger rather than of safety. There has been, consequently, but little encouragement for presenting to the public those facts which are requisite for guidance in applying the discovery of Franklin, successfully, to the protection of life and property.

The fact of electrical conduction by metallic substances having been long and well established, any further discussion of the application of this principle to the purpose of protection against injury by lightning may possibly appear, to persons conversant with such subjects, in some degree superfluous. The damage, however, which so frequently occurs in thunder-storms, attended, as it is, with loss of life and with serious inconveniences to the best interest of the country; the various theories advanced by persons who have only partially considered the facts; systems of rodding which have been adopted in different localities, and the numerous modifications of the conductors, each claiming some peculiar advantage over all its competitors, has created a curiosity, if not a necessity, which seems to call for investigation, and may be fairly offered as a sufficient reply to such an opinion.

When we consider the coincidences of lightning and ordinary electricity, together with the fact that atmospheric electricity may be conducted from the clouds, or strata of charged air, and applied to produce the same effects as those resulting from electricity generated by means of an electric machine, it becomes quite evident that the causes, whatever they may be, of ordinary electricity are identical with those of lightning; consequently we arrive at the important conclusion that lightning and common electricity are subject to the same

* Abstract of a paper read before the Meteorological Section of the Franklin Institute of Philadelphia. From the "Journal of the Franklin Institute."

laws—a deduction which cannot be too forcibly insisted on, involving as it does the most valuable practical consequences.

The accumulation of electricity by artificial means may be carried to almost an indefinite extent, and is equally manageable whatever may be the extreme limit of force we choose to assign to such accumulation. It therefore necessarily follows that discharges of atmospheric electricity may be quite as easily directed by a judicious and scientific arrangement of conducting bodies; such discharges being, in fact, nothing more than discharges of the same force accumulated in a similar way by means of an apparatus of a perfectly similar kind.

The vapoury masses of electrified clouds opposed to the surface of land or sea oppositely electrified, by induction, with the non-conducting medium, air, intervening, constitute a battery of enormous power.

The circumstance of the coatings of the Leyden jar being metallic, while those of nature consist of clouds and opposed land or sea, is a difference of no consequence whatever, especially when we consider that the original Leyden jar of the Dutch philosophers consisted of a phial filled with water, from which they obtained so severe a shock that one of them said he would not again receive it for the whole kingdom of France.

It is conceded that the atmosphere contains free, or uncombined, electricity; that clouds as they pass through the air collect and retain it in large quantities, thus becoming electrified bodies; that they are sometimes positively, sometimes negatively charged; that it is impossible to have a body charged with one kind of electricity without having an equal amount of the opposite kind accumulated in near or distant bodies; that the attraction between the opposite electricities is mutual, and that it increases as the distance diminishes.

It is well known that an electrified cloud acts upon the earth by induction; decomposes the combined electricity in every object over which it passes; repels the electricity of the same kind as that contained by itself, and attracts the opposite kind. The earth and objects beneath an electrified cloud are in this manner charged by induction. When the attraction between the opposite kinds of electricity becomes greater than the resistance of the intervening air, a discharge takes place. It is this accumulation of free electricity upon buildings, by induction, which offers the attraction for the opposite electricity contained in the electrified cloud, or stratum of atmosphere, that causes them to be struck by lightning. The accumulation of free electricity in large quantities is the necessary condition, and the effects follow as a natural consequence. Thus his Majesty's ship *Dictator* was struck and damaged by lightning at Martinique, in the year 1794, during fine weather and a clear sky.

If a discharge takes place, from any cause whatever, at any point, the cloud is left in a neutral condition, induction instantly ceases, and all the bodies charged by induction instantly return to a neutral state.

The suddenness of this return is what is known as the return stroke, and often kills men and animals, or destroys buildings which are at the time at a great distance from the place where the direct discharge occurs. All the terrible effects of the return stroke may result when the direct discharge has been between two oppositely electrified clouds.

There is one law of electrical action which some electricians lose sight of entirely in considering the subject under immediate investigation, viz., that large quantities of electricity pressing upon small surfaces become quite unruly, and when the surface is reduced to a mere point, the tension becomes so great as to give rise to an escaping current. If, instead of terminating the rod in a ball, we use a finely plated point attached to the building, we will at once have a flow of free electricity from the building into the air by means of the rod and point, and as the particles of air become charged they will be repelled by the electricity being conducted from the earth by the rod, and attracted by that contained in the cloud. The escape of electricity from the points of the electric wheel, and the effect produced upon a charged conductor, when slowly approached with a metallic point, held in the hand, are demonstrations of the fact that electricity escapes from points, and neutralises charged bodies with which they are not in contact. Thus it will be seen that a pointed conductor, placed directly in contact with a building, tends to prevent the accumulation of electricity upon it, and also to neutralise the charged cloud; hence it may prevent a disruptive discharge which might otherwise occur. If the rod be removed from the building by insulation, it is powerless to prevent the accumulation of electricity on the building by induction; hence by insulating a rod we lose its most valuable influence. If a discharge falls upon an insulated rod, and be conducted by it to the earth in safety, and without intermediate explosion, still the conditions requisite for a return stroke are present, and the insulated rod is powerless to prevent injury to the building or its contents at the *very instant* of the direct stroke.

Phenomena of this character are quite frequent, especially where buildings have gas or water pipes to lead the return stroke into the house, and in consequence many have condemned the use of lightning-rods without investigating the cause of the disasters.

The closer rods are applied to the walls of a building the better; indeed, it is absolutely necessary to attach the rod directly to the object to be protected, to insure safety, for no other way can we guard against the return stroke, which kills more people and destroys more property than the direct stroke.

The rod must not be placed at a distance from the object to be protected, nor pass over nor through rings of glass or other insulators. Insulators are not only useless but are positively dangerous before rain falls; after rain falls they require some degree of conducting power; at best, they are entirely useless as a means of safety, make an insecure fastening, and allow the rod to rattle sufficiently to disturb sick or nervous people at all seasons of the year. Their use should be discontinued, and some method taken to induce parties, having rods upon their buildings which are insulated, to remove the glass.

It is a physical impossibility for any object to be injured by lightning if the conditions of safety known to be demanded are fully complied with.

I have no doubt but the case mentioned in Silliman's "Physics," page 662, second edition, illus-

trates the results of insulation. It is stated: "In a church in New Haven the lightning has twice penetrated a 20-inch brick wall at a point opposite a gas-pipe 20 feet above the earth, although the conductor of ¾-inch iron was well mounted, but its connection with the earth was less perfect than that of the gas-pipe." I suppose "well mounted" to mean well insulated. Now, suppose lightning to fall upon this well insulated rod and be conducted by it to the earth in safety, or a discharge to take place between two clouds. In either case the building would at the same instant return to its normal condition, and the gas-pipe would be part of the line over which the electricity would pass to restore the equilibrium. The effect produced by lightning on this church upon two different occasions are such as might have been anticipated, and are likely to occur again, unless the rod be attached directly to the building, *and also to the gas-pipe* near its upper terminus. It will make but little if any difference at what point the rod and gas-pipe are united; if the connection be made about the building it will be less liable to get out of order than it would be if made in the earth. It is contrary to all known laws of electrical action to suppose that electricity, passing over a rod which penetrates the earth would leave such conductor before reaching its termination, unless some other equally as good a conductor is in contact with it and also extending to the earth, in which case the charge would be carried in part by each without injury to surrounding bodies, providing one of the conductors be a ¾-inch iron rod.

The distribution of free electricity over the surface of electrified bodies, depends upon their form and the position which they occupy with respect to surrounding bodies.

It is conceded that the greater the curvature of a surface at any part, that is, the nearer it approaches a point, the greater will be the accumulation of electricity there; that electricity tends to flow towards, or accumulate at, the pointed portions of bodies; that metallic bodies of a pointed shape soon lose the electricity imparted to them, and that it is impossible to charge a conductor when a sharp point projects from it, or of one having conducting communication with the earth is held near it. Points are of value aside from preventing the accumulation of electricity on the object to be protected, and their tendency to lessen the intensity of the cloud. Having become the origin of an active mechanical force, they, by the very act of causing that force, namely, by discharge, prevent any other portion of the conducting body from which they project from acquiring the same conditions, and thus preserve their own predominance.

A geometrical point is without dimension. A practical point has dimensions which are, in comparison to some other body, quite insignificant. Some electricians, still accepting the one-fluid theory of Franklin as being true, claim that points draw off electricity silently and quietly from charged bodies with which they are not in contact; that a cross section of any lightning rod would be an infinitely small point in comparison to a cloud, and therefore the points upon lightning rods are useless except as ornaments.

The cross section of a lightning rod would be, as claimed, an infinitely small point in comparison to the area of a cloud; but, unfortunately for the advocates of the one fluid theory, points do not receive electricity from charged bodies with which they are not in contact, except in cases of disruptive charge.

The silent flow is always from points, never towards them. Electricity cannot leave the cloud except by conduction or disruptive discharge. The upper termination of a lightning rod must be a mere point in comparison to a cross section of the rod upon which it is used. The object in terminating the rod in a point is to increase the electrical tension at its upper extremity sufficiently to give rise to an escaping current of electricity from the rod. If the upper portion of a lightning rod be insulated and separated from the lower section by a slight opening, electric sparks will pass through the space during the passage of electrified clouds so rapidly that neither the eye nor the ear can discover the intermissions. If the point be removed the sparks will cease. This experiment demonstrates the value of points, and proves that lightning rods do tend, as before stated, to neutralise charged clouds.

TABLES TO FACILITATE THE CALCULATION OF STRAINS OF SUSPENDED (IRON OR STEEL) WIRES.

(FOR THE USE OF LINEMEN).

By ROBERT SABINE, C.E.

TABLE I.—THE SUSPENDED WIRE.

Col. 1. Relation of sag to span. $h : l$.	Col. 2. Number proportional to strain. K.	Col. 3. Number proportional to length of wire (Span = 1) L.
1 to 10	4·67	1·02667
1 ,, 15	6·62	1·01185
1 ,, 20	8·68	1·00667
1 ,, 25	10·74	1·00427
1 ,, 30	12·83	1·00296
1 ,, 35	14·92	1·00218
1 ,, 40	17·02	1·00167
1 ,, 45	19·11	1·00132
1 ,, 50	21·21	1·00107
1 ,, 60	25·43	1·00074
1 ,, 70	29·64	1·00054
1 ,, 80	33·86	1·00042
1 ,, 90	38·07	1·00033
1 ,, 100	42·29	1·00027
1 ,, 110	46·52	1·00022
1 ,, 120	50·74	1·00019
1 ,, 130	54·96	1·00016
1 ,, 140	59·18	1·00014
1 ,, 150	63·40	1·00012
1 ,, 160	67·63	1·00010
1 ,, 170	71·85	1·00009
1 ,, 180	76·07	1·00008
1 ,, 190	80·30	1·00007
1 ,, 200	84·52	1·00006
1 ,, 225	95·08	1·00005
1 ,, 250	105·64	1·00004
1 ,, 275	116·21	1·00004
1 ,, 300	126·77	1·00003
1 ,, 350	147·89	1·00002
1 ,, 400	169·02	1·00002
1 ,, 450	190·14	1·00001
1 ,, 500	211·26	1·00001

RULES FOR USING THE ABOVE TABLE.

I. *The span and sag being given, to find the absolute strain per square inch section.*

Rule.—In column 1 find the nearest relation of sag to span, and opposite to it (in col. 2) the proportional strain (K). The absolute strain in lbs. is = K times the span in feet.

Example.—If a steel wire were to be stretched across a river (span 2340 feet), and on account of shipping only 39 feet sag could be allowed, what would be the absolute strain?

$$39 : 2340 :: 1 : 60.$$

In the table opposite the proportion 1 : 60 is given (col. 2) the proportional strain (K) = 25·43 lbs. The absolute strain is therefore $25{\cdot}43 \times 2340 = 59506$ lbs. per square inch.

II.—*The span and sag being given, and also the sectional area of the wire in square inches, to find the actual strain in lbs.*

Rule.—To column 1 find the nearest relation of sag to span, and opposite to it in col. 2) the proportional strain (K). Then the actual strain in lbs. is—

K × area of wire × span in feet.

Example.—Span of 111 yards with a sag of 20 inches (=1 to 200). Required the actual strain of a No. 11 B.W.G. iron wire.

In col. 1 opposite 1 : 200 we find K = 84·52.

The sectional area of No. 11 wire is = 0·0125 sq. inch. Therefore the actual strain will be—

$$84{\cdot}52 \times 0{\cdot}0125 \times 333' = 352 \text{ lbs.}$$

III. *The span and sag being given, to find the length of the suspended wire.*

Rule.—In column 1 find the nearest relation of sag to span: column 3 gives the proportional length (L). The actual length is = L times the span in feet.

Example.—Span 200 feet; sag 10′ = (1 : 20). The proportional length of which is 1·0067. Therefore: length = $1{\cdot}0067 \times 200 = 201{\cdot}34$ feet.

IV. *The span and maximum actual strain of a wire being given to find the necessary sag.*

Rule.—Divide the given maximum strain in lbs. by the area of the wire in inches multiplied by the span in feet; and with the quotient refer to col. 2 of the table for the nearest value. Opposite to this, in column 1, you will find the sag.

Example.—It is wished to stretch a No. 8 steel wire across a space of 2000 feet, in such a way, that the maximum strain upon it will not exceed 900 lbs. The area of No. 8 wire is 0·023 sq. inch, and

$$\frac{900}{0{\cdot}023 \times 2000} = 19{\cdot}565.$$

In column 2 the nearest value to 19·565 is 19·113, corresponding to a sag of 1 : 45. The sag will therefore have to be—

$$\frac{2000}{45} = 44\tfrac{4}{9} \text{ feet.}$$

V. *Two neighbouring spans of different lengths, which do not form an angle at the post, being given, to find the sag which one wire must be allowed in order to balance the strain of the other on the common support.*

Rule.—Having found the actual strain of the first section, the sag of the second is calculated by the Rule IV. given above.

Example.—A span of 2000 feet is crossed by a No. 8 wire (area = 0·023 sq. inch), having 44⅘ feet sag (1 : 45), and therefore an actual strain of

$$19{\cdot}11 \times 0{\cdot}023 \times 2000 = 879 \text{ lbs.}$$

The neighbouring span is only 400 feet.

$$\frac{879}{0{\cdot}023 \times 400} = 95{\cdot}5 \quad \text{(See Rule IV.)}$$

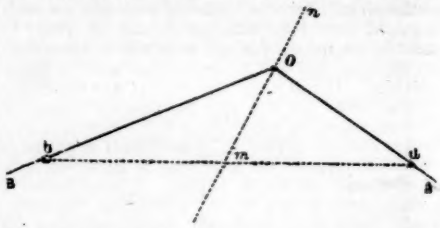
In column 2 the nearest value to this is 95·08, corresponding to a sag of 1 : 225. The wire must therefore be pulled up till the sag is

$$\frac{400}{225} = 1{\cdot}8 \text{ feet, or about 21 inches.}$$

VI. *Two neighbouring spans having different strains, and making an angle at the post being given, to find the best direction for a strut or stay.*

Rule.—Find by the foregoing rules the two strains. Measure off from the pole in the direction of each wire a length proportional to its strain. Join the ends of the measured lengths by a straight line, the middle point of which sighted towards the post gives the best line of strut and stay.

Example.—From the post, O, are two wires. The strain of A is 600 lbs.; that of B is 900 lbs. I measure off, in the direction O A, a length of 10 feet, to *a*; and in the direction, O B, a length of 15 feet to *b*, (because 10 and 15 are proportional to 600 and 900).



The points, *a* and *b*, I then join by a straight line, *a b*, the middle of which is at *m*. Therefore a strut should be placed in the line *m* O. If I want a stay, I sight the line on the other side of the post towards *n*, and place the stay in the direction, *n* O.

VII. *The span, sag, and temperature (in deg. centigrade) of a wire being given, to calculate the effects of an alteration of temperature.*

Rule 1.—Take from column 3 of the table the proportional length corresponding with the given span and sag.

2.—Then {increase / decrease} this proportional length by 0·0012 per cent for every degree centigrade which the altered temperature is {above / below} the original temperature.

3. Lastly.—With the altered proportional length, find (in column 3) the nearest value, and in column 1 the corresponding sag. The proportional strain in column 2 multiplied by the span in feet gives the resulting strain in lbs. per sq. inch of section.

Example.—An iron wire was stretched across a span of 400 feet, with a sag of 5 feet (= 1 : 80), at a temperature of 25° C.; the absolute strain upon it was therefore $400 \times 33{\cdot}86 = 13543$ lbs. per square inch. In winter, during a frost of −5° C., what would the sag and strain become?

1.—By column 3 we find that the proportional length for sag 1 : 80 would be 1·00042.

2.—The difference of temperature (+25° to −5° C.) would be 30° and $30 \times 0{\cdot}0012$ per cent = 0·036 per cent. Then—

$1{\cdot}00042 - 0{\cdot}036$ per cent = $1{\cdot}00042 - 0{\cdot}00036 = 1{\cdot}00006$.

3.—In column 3 we find the proportional length 1·00006 corresponding to a sag of 1 in 200, and (col. 2), a strain of about 85 lbs. $85 \times 400 = 34000$ lbs. per sq. inch, which would be sufficient to permanently stretch the wire.

(To be continued).

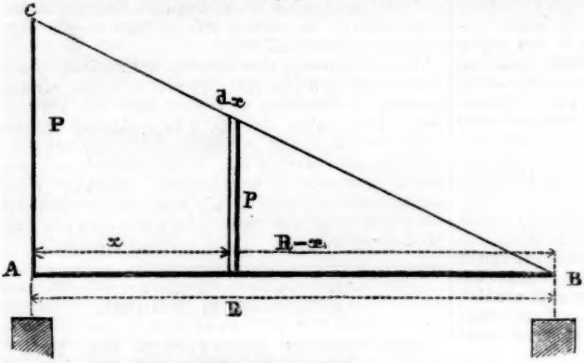
Mr. Scudamore contradicts the statement that the Post-Office authorities are making enquiries with a view to the purchase of the Atlantic cables.

Students' Column.

On the Flow of Electricity at the Two Ends of a Charged Cable. By H. R. Kempe.

When a well-insulated cable, whose further end is insulated, is charged by means of a battery at the nearer end, the potential at all parts of the cable is the same; and if the two ends are then put simultaneously to earth, obviously an equal amount will escape at each end. The case, however, is different if the cable is charged when the further end is to earth, for in this case the potential falls to nothing at that point.

Let R represent the resistance of the conductor of the cable. The cable having been charged with the further end to earth, the battery is taken off, and the nearer end immediately put to earth also.



Let P be the potential at the nearer end at the moment this end is put to earth, and let the area of the triangle, A B C, represent the charge in the cable. Let $p\,d\,x$ be a differential part of this area. This will split into two parts, one part going towards A, and the other towards B, in the proportion of $R-x$ to x. The total quantity (Q) flowing out at A will then be—

$$Q=\int_0^R p\frac{x}{R}\,dx.$$

now— $$P : p :: R : R-x,$$

therefore— $$p=P\frac{R-x}{R}$$

therefore— $$Q=\frac{P}{R}\int_0^R (R-x)\,dx$$

$$=\frac{P}{R^2}\left(R^2-\frac{R^2}{3}-R^2\right)=\frac{PR}{3}$$

and the quantity (Q^1) flowing out at B will be—

$$Q^1=\frac{PR}{2}-\frac{PR}{3}=\frac{PR}{6}$$

therefore $Q=2\,Q^1$, which shows that twice as much flows out at A as at B.

The American Institute of New York has awarded "the Great Medal of Honour" to Joseph B. Stearns, for the invention of the duplex telegraph. The American Institute is a very old and eminent society and is understood to have made the present award after a most careful and exhaustive examination as to the novelty and value of the invention.

PAPERS FOR JUNIOR STUDENTS.

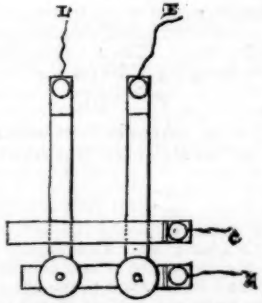
Reversals.—The Single Needle Instrument, &c.

Hitherto we have studied the principles of our instruments under the condition that the electric current is supposed to pass through the coils in only one direction.

The direction of a current, it should be premised, is generally accepted to be from the negative pole (or copper, or carbon, or what not) to the zinc, or positive pole; the reverse being the direction between the plates of the battery. Calling this the *direction* of the current, study of the law given by Ampère as to the effect of a wire conveying a current of electricity upon a magnetic needle, will show that if by joining the copper pole of our battery to one end of the wire and the zinc to the other, we obtain a deflection to one side, say to the

Fig. 1.

Fig. 2.



right, reversing the poles of the battery, putting the copper pole where was the zinc, will result in a deflection to the opposite side, to the left. In Fig 1 is shown a magnetised needle or bar, suspended vertically in a coil of wire, also vertical as regards its convolutions. The magnet, N S, is mounted upon a horizontal axis, to which axis is also rigidly affixed the index or pointer, $p\,p'$, generally a light bar of steel or ivory. A current passed in one direction through the coil of wire deflects the needle, say to the right, against the stop or pin, d'; a current in the opposite direction sends the needle and the pointer to the left, against the stop d. Thus we may, by employing a deflec-

tion to the right for a dash, a deflection to the left for a dot, transmit messages by the Morse code* between instruments at two places connected by wires.

But actually to reverse the battery connections would render such a method of signalling very slow work; and consequently, what is termed a "set of reversing keys" are employed. The reversing key is shown in Fig. 2. The key consists essentially of two brass springs, L E, these springs pressing upwards against a transverse bar, *c*. Supposing the wires from L and E connected to the ends of the coil of the needle instrument above, a perfect metallic circuit would be formed. Another brass bar, Z, placed below the springs or keys L E is at such a distance that the springs or keys may easily be pressed down upon it. Let the copper pole of the battery be joined to the bar, *c*, and the zinc pole to the bar, *z*, by copper conducting wires; the ends of the coil above being connected to L and E. Then clearly, if the right-hand key is pressed down, we shall have a current from the zinc pole of the battery passing along that key, through the coil of the instrument, deflecting the needle to the right, passing by the left hand key to the bar connected to the copper pole of the battery. Pressing down the left hand key, we obtain a similar result, but differing in direction. This is the *principle* of the single needle instrument, by which messages are transmitted by means of the deflections of the pointer to right or left. Instead of connecting directly the springs L and E to the ends of the coil of wire (because in that case each set of keys would work only its own needle), one, L, is connected to an end of the coil, the other end of the coil to the line wire, and E is connected to the earth plate. So that a current *received* on the instrument would pass (as long as either of the keys were not pressed down) through the coils, down the key L, across the bar *c*, to the key E, and thence to earth.

In practice, however, needle instruments are not frequently constructed in this simple manner, which has its disadvantages. The more complicate forms, of which the foregoing is the principle, will be duly discussed when we have grasped the elements of the science.

The system of reversals described is that employed by Sir William Thomson in the transmission of signals by means of his reflecting galvanometer. Substituting for the needle-coil the coils of the galvanometer (Fig. 3, page 253), the ray of light would be deflected to the right or to the left, by pressing the right or left hand key. Thus messages are read by calling the movement of the light to the right a dash (—), and a movement to the left a dot (·).

Before we leave the subject, it will perhaps be better to explain why the north end of the magnet-needle is placed in the lower position in the coils of the needle instrument. Referring to the ordinary mariner's compass—and all freely-suspended magnetic needles are subject to the same laws as those of the compass—Dr. Atkinson, in his translation of Ganot's "Physics," explains the phenomena known as "dip" in the following words:—"It might be supposed, from the northerly direction which the magnetic needle takes, that the force acting upon it is situated in a point of the horizon; this is not the case, for if the needle be so arranged that it can move freely in a vertical plane about a horizontal axis, it will be seen that, although the centre of gravity of the needle coincides with the centre of suspension, the north pole in our hemisphere dips downwards. In the other hemisphere the south pole is inclined downwards. The angle which the needle makes with the horizon, when the vertical plane in which it moves coincides with the magnetic meridian, is called the *inclination* or *dip* of the needle. In any other plane than the magnetic meridian the inclination increases, and is 90° in a plane at right angles to the magnetic meridian. . . . The value of the dip differs in different localities. It is greater in the polar regions, and decreases with the latitude to the equator, where it is approximately zero. In London at the present time the dip is 67° 54′, reckoning from the horizontal line. In the southern hemisphere, the inclination is again seen, but in a contrary direction, that is, the south pole of the needle dips below the horizontal line."

Thus we can see that were the magnetised needle hung with its north pole upward, it would always maintain a tendency to depart from the vertical line. By making the north pole slightly heavier than the south, and giving the latter the superior position, the vertical line is maintained, and the needle is said to be "compensated for dip." With instruments exported to the southern hemisphere, the compensation is effected by a contrary hanging of the needle.

* See page 224 of this Journal.

Proceedings of Societies.

THE BRITISH ASSOCIATION FOR THE ADVANCEMENT OF SCIENCE.

Bradford Meeting, 1873.

Section A.—Mathematical and Physical Science.

The President, in his opening address, said he did not propose, as a specialist, to sketch the progress of mathematical science, but to point out some of the services which sectional meetings such as this have rendered or may be expected to render to science. Section A includes a vast range of subjects, from the most abstract—as space of five dimensions—to the most concrete—as the rain-fall of the British Isles. It has been well said that our knowledge of nature as it advances continuously resolves difference of quality into difference of quantity. All reasoning about quantity is mathematical reasoning, and thus as our knowledge increases that portion of it which becomes mathematical increases at a still more rapid rate. So close is the union between mathematics and physics that the greater part of mathematics has been discovered in the endeavour to solve physical problems. Sometimes the physicist has found his weapons ready forged in the armoury of the mathematician, but this is less frequent. An example of each shall be cited. (1). The conic sections, when first studied by the Greek geometers, presented a problem which was one of mere curiosity. If Euclid and Appollonius had been told by any of their contemporaries that they were giving a wholly wrong direction to their energies, and that, instead of dealing with the problems presented to them by nature, they were applying their minds to inquiries which not only were of no use, but which never could come to be of any use, they could give no answer which might not now be given by mathematicians who study quatics of n indeterminates, curves of nth order, or spaces of n dimensions. And the ob-

jection remained without an answer for nearly 2000 years, until the time of Galileo and Kepler, who found them ready to hand for the expression of new facts. It is not too much to say that without the treatises of the Greek philosophers there would have been no Kepler, without Kepler no Newton, without Newton no exact idea of science. (2). In Professor Clerk Maxwell's "Treatise on Electricity" we have a complete account of a theory which has already added largely to the methods and resources of pure mathematics, and which may one day render to that abstract science no less than what it owes to astronomy. The great practical importance of telegraphy has caused the methods of electrical measurement to be rapidly perfected to an extent which render their accuracy comparable to that of astronomical observations, at a time when the scientific interest in the older mathematical astronomy has for the moment flagged.

The President then passed to consider the definite services rendered by Section A,—to consider the system of science teaching, to recommend the use amongst students of such books as "Deschanel's Physics," edited, or rather re-written, by Professor Everett; Professor Balfour Stewart on "Heat;" Professor Clerk Maxwell on the "Theory of Heat;" Professor Fleeming Jenkin on "Electricity."

THE AMERICAN ASSOCIATION FOR THE ADVANCEMENT OF SCIENCE.

An Automatic Filtering Apparatus was exhibited by Dr. H. W. Wiley, which consists of an ordinary filter-stone with two arms. The upper arm carries a large funnel of from one to three quarts capacity, an electro-magnet with a system of levers for working a stop to the funnel, and a glass bulb and mercury cup. The lower arm is fitted with an ordinary Bunsen funnel, in which floats the glass bulb attached by a platinum wire to a lever carrying the mercury cup. As the fluid in the small funnel falls, the float sinks, and the mercurial cup rises, until the mercury touches two platinum wires, which are the poles of a small galvanic battery connected with the electro-magnet. This completes the circuit. The armature of the magnet is pulled down, the stop in the large funnel is raised, and the liquid runs through into the small funnel until the connection is broken. This continues until the whole of the fluid runs through into the small funnel. By means of this apparatus the quantitative analyst can save several hours daily.

FRENCH ASSOCIATION FOR THE ADVANCEMENT OF SCIENCE.

(Sections of Physics and Meteorology).

M. Mercadier submitted to the notice of the section his electro-diapason, recently described.

M. Tommasi read a paper "*On the Application of Ammonia to the Production of the Motor Force in Pneumatic Telegraphy.*"

The thermo-electric properties of pyrites, discovered by M. Marbach, have been studied in detail by M. Friedel (*Annales de Physique et de Chemie*), but M. G. Rose has found that certain crystalline forms give contradictory results to the experiments made by M. Friedel.

Notices of Books.

Workshop Appliances. By C. P. B. Shelley, Civil Engineer, Prof. of Manufacturing Art of Machinery in King's College, London. London: Longmans, Green, and Co.

Among the text-books of science, this present issue will be the most interesting to the artisan. It introduces a direct link between engineering literature and the workshop; perhaps it would be better to say that it is truly a workshop book. It will be interesting not only to the practical man for its elucidation of the common mechanical principles of his tools, but the amateur will find many of his minor practical difficulties solved as nearly as these can be by description. To the engineering student there is no doubt of its utility. Mathematics are discarded, an advantage in a work of this character. The greatest imperfection we can discover is that the book is too short; another volume would quadruple its value.

Obituary.

DR. NELATON.

It is with the greatest regret that we receive information of the death of Dr. Nelaton, surgeon to the late Emperor of Napoleon, better known perhaps as the inventor of the celebrated bullet-probes, mechanical and electrical. Everyone is acquainted with the episode of Aspromonte, where the Italian liberator Garibaldi was wounded, but everyone is not so well acquainted with the unselfish conduct of Dr. Nelaton in the cell of the wounded man at Spezzia. Summoned from a remunerative practice, declining to accept fee or reward, Dr. Nelaton invented his electric probe and saved his noble patient's life. Dr. Nelaton was in 1866 appointed surgeon to the Emperor, a year later made a Grand Officer of the Legion of Honour, and in another year was raised to the rank of Senator. No man more justly deserved honour or recognition; for to a character of the greatest probity, Dr. Nelaton combined the graces and suavity peculiar to his nation, and it has been said of him "that the doctor as much as the medicine cured his patient."

Correspondence.

COUNT DU MONCEL ON THE PROPERTIES OF ELECTRO-MAGNETS.

A l'Editeur Telegraphic Journal.

Monsieur,—Je viens d'arriver a et j'y trouve votre excellent recueil au quel je me suis abonni. Je vous remercé beaucoup d'avoir aussi longuement parlé de mes travaux et le soin que vous apportez à résumer tout ce qui se fait en electricité bien des recherches à l'avenir. C'est donc pour moi une bonne fortune de posseder cet ouvrage.

Comme vous accueillez avec bienviellance les observations que vous sont faites permettez-moi de rectifier une petite erreur de formule que vous avez commise dans le compte rendu de mon dernier travail, p. 256. La valeur de g n'est pas—

$$\sqrt{f\frac{\sqrt{c^2}}{R}\cdot 0{\cdot}0001005312}$$

$$\text{mais } g = \sqrt{f\frac{\sqrt{c^2}}{R}\cdot 0{\cdot}0001005312}$$

D'un autre coté la valeur de c ne peut pas être déduite de l'equation seule—

$$\frac{I't}{I't'} = \frac{\sqrt{c'^2}}{\sqrt{c^2}}$$

Car les quantités t' et t sont inconnues et elles doivent être exprimées en fonction de c. Or d'après les conditions de maximum discutes, les quantités doivent

être egales à $\frac{mc'^2}{g'^2}$ et à $\frac{mc^2}{g^2}$ et comme la valeur de g'^2 peut être déduite de l'equation—

$$I' = \frac{E'}{R' + \frac{2\pi c'^2 m}{g'^2}}$$

On arrive à l'expression—

$$c' = \sqrt[5]{\left[\frac{(E' - I'R')\,10g^2}{2\pi m I}\right]^2}$$

et en convertissant en une seule constant la valeur—

$$\left(\frac{10g^2}{2\pi m}\right)$$

composée de quantités connues se rapportant à l'electro-aimant type employé et placé dans bonnes conditions de saturation, on arrive à la formule simple—

$$c' = \sqrt[5]{(E' - I'R')^2 \,.\, 0{\cdot}000000000000003397017 61}$$

I' indiquant l'intensité du courant dans la circuit ou doit être interposé l'electro-aimant, circuit dont la resistance est egale à 2 R'; E' representant la force electro-motive de la pile qui doit être employé.

Dans les *Comptes Rendus de l'Academie des Sciences* l'indice du radical de l'expression precedente a été enleve à l'impression.

Pardon d'abuser ainsi de vous mais comme c'est dans l'interet de la science que je les sais vous me le pardonnerez j'en suis certain.

Ces deux formules donnant les valeurs de c et de g sont très commodes dans les applications electriques et je les ai employées plus d'úne fois. Avec les logarithms elles sont très faciles et très promptes à calculer.

Je vous prie d'agreer l'assurance de mes sentiments les plus distingués.

TH. DU MONCEL.

Lébisey près Caen, Sept., 1873.

J'oubliais de vous dire que dans l'equation—

$$\frac{I't'}{It} = \frac{\sqrt{c'^2}}{\sqrt{c^2}}$$

le typographe Anglais a pris l'accent pour un 1 ce qui fait que c represente un puissance trezième. Ce qui est faux c'est donc $\sqrt{c'^2}$ et non $\sqrt{c'^{13}}$.

TELEGRAPHIC COMMUNICATION AND THE ASHANTEE WAR.—The *Financier* says: "We all know the cost of war, and we all know how greatly that cost may sometimes be diminished, and anxiety relieved, where there is the advantage of instantaneous communication. An opportunity now presents itself which the Government may do well to consider. Here is the Great Eastern just arrived, having on board one thousand miles of cable, intended for the Atlantic, but which will not be needed for that purpose for some considerable time to come. On the other hand, the Brazilian Telegraph Company are now engaged in laying their line from Lisbon to Madeira; it is thence to be extended to St. Vincent by the end of this year. Were the Government to make terms with the companies concerned, they could, doubtless, secure the laying of this cable to St. Vincent immediately. This might prove of vast advantage in the coming war. Nay, the Government might even arrange to have a line run along the 700 miles from St. Vincent direct to Sierra Leone. The suggestion deserves due attention."

Electrical Science in Foreign Journals.

Comptes Rendus Hebdomadaires des Séances de l'Academie des Sciences, Vol. lxxvii., No. 10.

Note on Magnetism (Continued).—By M. J. M. Gaugain.—Those who have studied the carrying force of iron horse-shoe magnets have stated that this force increases with time, in such a manner that the prolonged contact of the armature has the effect of gradually augmenting the magnetism developed at the extremities of the horse-shoe. It would be interesting to ascertain if this gradual increase could be explained by the method of induction currents. Consequently, I placed on the extremity of one of the branches of an iron horse-shoe magnet a bundle of wires which I put in communication with a galvanometer. I applied to the polar faces an armature of soft iron. This contact was maintained during some seconds as well as for hours and days; the value of the result being determined by the current of demagnetisation. This current preserved very nearly the same value. The result is thus opposed to the general opinion stated at the commencement. It should be said that the magnets with which I experimented are of kind termed by Mr. Haecker constant. I had hitherto occupied my attention with experiments on permanent magnets; but I have to make known my results with electro-magnets. I have particularly studied a form of electro-magnet most frequently in use, composed of a bar of soft iron in the form of a horse-shoe, with two bobbins placed respectively on the branches near their extremities. To ascertain the curve of demagnetisation for such an electro-magnet, it will be necessary only to place successively at different points of the bar a coil of wires communicating with a galvanometer, and to determine for each position of the coil the value of the induced current developed at the moment the inducing current is interrupted. This method should give the same results as were given with the permanent magnet. But, rigorously, this is not always the case. The iron being never entirely deprived of its coercitive force, preserves in general a certain magnetisation after the inducing current has ceased to circulate in the bobbins. And there is the result that the induced current developed at the moment when the inducing circuit is interrupted is nearly always a little stronger than the induced current that would be obtained in completely and instantly removing the coil from the influence of the bar.

Les Mondes. Vol. xxxii., No. 2.

Electric Resistance of the Human Body.—By M. l'Abbe Moigno.—(A eritique).—The *Gazette des Hôpitaux* says:—"Very erroneous ideas are current as to the resistance the human body can oppose to the electric current; and these, general to day among those occupied with electro-therapeutics, depend often upon the selection of apparatus employed. During last year M. le Fort announced that he had obtained some remarkable results by the continuous use of a battery formed of only one or two elements; but opposed to this, and rendering it difficult to receive, he says, 'the tissues of man being very bad conductors, a current of such feeble tension can never surmount the resistance.' The argument is peremptory. I wished to know if it were founded on fact; and I addressed my observations to M. Ruhmkorff. He instituted an experiment in which, by the aid of a very delicate galvanometer, he found that the current formed by a single very small element, easily traversed a circuit formed of thirty persons.' In 1849, in the first edition of my "Traité de Telegraphie Electrique," I describe an experiment made at Utrecht, by Professor Van Reis, 'The imperceptible current from

the contact of two wires, the one steel, the other zinc, plunged into distilled water, after having traversed two long copper wires, the bodies of two men, and the earth for a distance of ten metres, gave a deflection of 10° upon a galvanometer of M. Berker, of Arnheim.'"

Journal of the Telegraph. Vol. vi. Whole No. 140.

Directions for Setting up the Gravity Battery.—Place the copper plate in the bottom of the glass jar, and put two pounds of sulphate of copper (blue vitriol) on top of the copper plate. Place the copper frame for holding the zinc on top of the glass jar, and suspend the zinc as near the top of the jar as possible. Fill the jar, within half an inch of the top, with water. If you have any of the sulphate of zinc taken from the porous cup of a Daniell's battery, put a teacup full of it in the jar. If you have none on hand, use about two ounces of sulphate of zinc (white vitriol) for each cup. If you have none of this at hand, use the same quantity of Glauber salt (sulphate of soda), or even common salt (muriate of soda). It is not necessary, however, to use anything but blue vitriol and common water. In this case, the two poles of the battery should be connected together in short circuit for twenty-four hours, during which time it will make its own sulphate of zinc, and will be ready for use. It is better to put the sulphate of copper, sulphate of zinc and water in the jar, and let them stand until the solutions separate before the zinc is placed in the jar. When the solutions have properly separated, the lower part of the jar will contain a blue fluid, and the upper part of the jar a white or colourless fluid. The zinc should always remain in a colourless solution. In case the zinc is put in the jar before the two solutions of sulphate of zinc and sulphate of copper have separated, the zinc will be coated with a dark substance, and should be taken out and carefully washed. When the water in the upper portion of the jar becomes saturated with sulphate of zinc, the sulphate crystallises upon the zinc plate, stopping the action of the battery. The conducting power of a solution of sulphate of zinc is greatest when diluted with an equal quantity of water. Part of the solution should, therefore, be from time to time removed and replaced by water. When crystals form on the top and sides of the cell, in consequence of the water being charged with sulphate of zinc, they should be removed with a damp cloth. A little grease or fat, rubbed on the sides of the jar, near the top, will tend to prevent the formation of crystals. When all the sulphate of copper has been decomposed, the action ceases, and sulphate of zinc will be reduced upon the copper plate as a black powder. It is necessary, therefore, to provide a constant supply of sulphate of copper. A few crystals of sulphate of copper should always remain in the bottom of the jar, undissolved. The jars should not be disturbed when in use, as this would cause the solutions to mix. As the water evaporates from the jar, it should be replenished by a fresh supply.

Scientific American, Vol. xxix., No. 11.

Automatic Registering and Printing Thermometer.—By Prof. Hough, of Dudley Observatory.—The instrument consists of a glass tube bent in the form of a syphon, the closed leg of which is filled with alcohol and the open one with mercury. On the surface of the mercury in the open end, there rests an ivory float suspended from a delicate balance, having platinum wire attached to each end of the lever. When the column of mercury in the thermometer tube rises or falls from the effect of temperature, the platinum wires dip in small mercury cups underneath them, thereby causing a current of electricity to pass through one of two electro-magnets operating mechanism for giving motion to a fine micrometer screw. The motion of this screw elevates or lowers the balance, thereby breaking the circuit. Whenever a change of temperature equal to one tenth of a degree Fahrenheit occurs, the magnetic circle is completed, and the screw is moved a space equivalent to the change in the height of the mercury in the thermometer. At the same time the clockwork moves the type wheels indicating the temperature, which is printed at the end of each hour on a slip of paper moving in front of them. A pencil held against a revolving drum also records a continuous curve, exhibiting at a glance the height of the thermometer.

The Compass in Iron Vessels.—Captain R. B. Forbes, of Boston, Mass., states that the compass in iron ships is specially affected in certain localities on the coast of Nova Scotia, which accounts for the loss of steamers in that region. He further says that, in spite of corrections, applied in England, whereby iron ships may be safely navigated in a given course approximately west south-west and east north-east, when they come to head more to the north or south by several points on the American coast, their corrections, good on the coast of England, are valueless in some ships. It is well known that the heeling of the iron ship, the rolling, the pitching, the concussion of the waves, have an important effect upon the compass—hence, nothing but constant observations of the sun at noon and the north star can insure a correct course.

Poggendorff's Annalen der Physik und Chemie.
No. 6, 1873.

On the Electromotive and Thermo-electric Forces of some Metallic Alloys in contact with Copper.—M. Sundell.—The author employed, for determining the electromotive force, Edlund's method, based on the principle that a galvanic current, passing through an electromotor, produces in this, proportionally to its electromotive force, an absorption or production of heat, according as the current has the same direction as that of the electromotor, or is opposite to it. By measuring the absorbed or produced heat, the relative strength of the electromotive force is estimated. The author first gives, for comparison's sake, a determination of electromotive and thermo-electric force, of the combinations iron-copper and copper-bismuth. Then follow details of experiments with various alloys, whence the following table:—

	Electrom. Force.	Thermo-elec. Force.
12 bismuth, 1 tin. ..	254·74	270·69
8 „ 1 „ ..	234·18	236·39
4 „ 1 „ ..	137·49	145·75
Iron	82·36	86·12
2 bismuth, 1 tin ..	49·76	81·59
Copper ..	0	0
German silver ..	98·08	103·12
32 bismuth, 1 antimony..	295·01	295·24
Bismuth ..	417·14	460·06
32 bismuth, 3 antimony..	533·98	680·94

Thus it appears that a metallic alloy, like the pure metals, has the same position in the electromotive and the thermo-electric series. Moreover, if we divide the numbers of the second series by those of the first, the quotients are nearly equal (except in the last case, which, however, admits of explanation), the mean being 1·06. Hence the proportion between thermo-electric and electromotive forces of the alloys in question is constant, and it is equal to that for the combinations iron-copper and copper-bismuth. Another point noticed was, a steady decrease in electromotive force in the bismuth-tin alloys. Of the pure metals, bismuth shows a similar change. "If we consider that the thermo-electric behaviour of solid conductors is extremely sensitive to molecular changes, *e.g.*, slight

impurities, or mechanical displacement of the molecules through tension, twisting, pressure, &c.; it appears very probable that the phenomenon referred to depends on some molecular change. Through quick solidification in the cast, the free crystallisation of the alloy is hindered, and there arises a state of tension, from which the molecules seek to free themselves. At the same time there may be chemical changes, both of composition and decomposition." It is thought likely that the bismuth-antimony alloys are subject to a similar change, though this was too small to show an effect in the short time of experiment.

On the Electro-chemical Equivalent of Silver.—M. Kohlrausch.—The author's object was to determine as accurately as possible with present means, the relation of the magnetic to the chemical current unit. He used as electrolyte a 15 per cent. solution of nitrate of silver in a large silver vessel, serving as negative electrode, a silver rod being the positive. The following table, while showing results, will in part indicate the method:—

		I.	II.	III.	
Duration of current	t =	1979·7	2399·6	2699·5	sec.
Mean deflection (tangent compass) ..	a =	636·99	526·42	521·59	m.m.
Precipitated silver	M =	1135·52	1139·05	1269·29	mgr.
Mean position of bifilar magnetometer	d =	+19·5	+7·8	+5·9	scale parts.
Horizontal intensity of terrestrial magnetism	T =	1·8122	1·8400	1·8396	

Of these, $\frac{M}{t} = m$, the quantity of silver precipitate in a second. A formula for magnetic current strength i is given; and $\frac{m}{i}$ gives the amount of silver precipitated by unit current in 1 sec., *i.e.*, the electro-chemical equivalent of silver. The values thus obtained are—0·11362, 0·11365, and 0·11363, which closely agree (and the author points out that the voltametric measurement of currents would be a very accurate means of determining the intensity of terrestrial magnetism). The electro-chemical equivalent of water is deduced, and found to be 0·009476, or about 1¼ per cent. greater than that commonly accepted. M. Kohlrausch makes some observations on the choice of galvanic current unit; and gives reasons for thinking the chemical current-measure affords no advantage in practice over the absolute or magnetic. The water voltameter, especially, may often lead to quite false results, through polarisation, and through the omission (by non-physicists) to make correction for temperature and pressure. Moreover, the Jacobi unit (understanding by this the current which, in 1 minute, developes 1 cc. of oxyhydrogen gas) is superfluous, because identical with the magnetic or Weber, if only, instead of 760 m.m., the gas-volume be reduced to a pressure of 800 m.m. mercury. A simple and practically useful expression for the chemical value of the Weber is the following:—The unit current, according to absolute measure, separates 1 mgr. copper in 30 seconds. It separates 1 mgr. zinc in 29·3 sec.; or 1 mgr. silver in 8·85 secs. It decomposes 1 mgr. water in 106·1 sec., and produces 1 cc. gas in 52 secs. (at +17° and 745 m.m.) A third point treated in this paper is, the mechanical equivalent of heat as deduced from galvanic measurements. It is found that if a Daniell element produced the current 1 Weber, and if this current were (say through an electro-magnetic machine) wholly utilised in mechanical work, a weight of 1 gr. could be thus raised about 11·47 met. in one second.

Pyrometric Experiments.—M. Weinhold.—Of five different methods, expansion of air, expansion of solid bodies, calorimeter, tension of gas produced by dissociation from a solid substance and electrical resistance M. Weinhold prefers the last. Numerous experiments are detailed.

The Electric Resistance of Mercury in Absolute Measure.—M. Lorenz.—Reserved for full translation.

Bulletin de la Societe d'Encouragement pour l'Industrie Nationale. Vol. xx., No. 249.

On the Silvering of Gelatin Moulds for Electro-Plating.—By M. Hanisch.—It is generally recommended to metallise with graphite, or precipitated silver, or sulphide of silver, the organic surfaces on which we wish to obtain the electro-plating deposit. But all these means are suitable only for operations where great delicacy is not required, because the reliefs given by the gelatin being soft, necessarily suffer when we spread the conducting body upon them, and cause in consequence proofs which necessarily require more or less time to re-touch. Besides, these bodies have a low conductivity, and give place to deficiencies in the deposit of copper, and to faults in the proofs. M. Hanisch thinks that the direct precipitation, under the influence of the sun, of silver on the gelatin should be recommended, because this precipitation, favoured by the presence of organic matter, is much more exact, purer, more uniform, and covers much better. He therefore advises the following mode of operation. The films of gelatin destined to be metallised are pasted on glass with copal varnish; they are next steeped for an hour in a solution of tannin, in order to render them less sensible to the action of water, and then are plunged into the bath of silver until the surface of the mould is completely coated. The mould is then removed from the bath horizontally, exposed to the rays of the sun, and left thus to dry. The friable and superfluous silver is then removed by washing, leaving only the layer presenting the metallic lustre. As this layer possesses, to the highest degree, conducting power, we then easily obtain excellent proofs with the feeblest currents. In this mode of silvering, losses can result only from the absence of the brightness of the sun during the operation, from defects of equality in the humectation of the mould by the nitrate of silver, or by the removal of the metallic deposit after its precipitation.

Revista de Telegrafos. Vol. xiii. No. 18.

Meteorological Telegraphy.—By Senor Enrique de Arantave.—The continuation of a series of interesting papers relating to South American and Spanish meteorological telegraphy, but not suitable for abstraction or translation.

The Telegrapher. Vol. ix., No. 374.

Transatlantic Longitude Determined by the United States Coast Survey.—By Prof. J. E. Hilgard.—The exact determination of the longitude of some point in the Coast Survey, from the principal observatories of Europe, is a matter of the first importance. The methods of moon culminations, of lunar occultations, and of chronometer transportation, formerly employed, yielded results whose degree of accordance still left much to be desired. The success of the transatlantic cable rendered it possible to use the telegraphic method, which was promptly done in 1867, when the longitude between Harvard College Observatory and Greenwich was determined, under the direction of Dr. B. A. Gould, through the Ireland-Newfoundland cables. When the French cables from Brest to St. Pierre, and thence to Duxbury, were laid, a second determination was made, under the charge of Assistant G. W. Dean, in 1870, in order to check the accuracy of the method; but, as no cable was then laid between Brest and England, the link to connect with Greenwich was still wanting, and, carrying it by the French longitudes to Paris, and thence to Green-

wich, an indifferent agreement with the former value was obtained. The missing link was supplied in 1872 by Prof. J. E. Hilgard, who at the same time repeated the transatlantic determination. The plan of operations was to receive at Brest simultaneously the time signals from America, from Greenwich, and from Paris; thus referring the American station at once to both observations, and obtaining at the same time the difference of longitude between the latter. Next, the Brest observer successively visited, with his own instruments, all the other stations, in order to compare personal 'equations,' and while at Greenwich he exchanged time signals with the Paris observers, thus making an independent determination of that longitude through another cable. The following is a comparison of results:—

	Nights.	Mins.	Secs.
Brest—Greenwich ..	6	17	56·13
Greenwich—Paris ..	5	9	21·11
Brest—Paris (sum) ..		27	18·24
Brest—Paris (direct) ..	9	27	18·18

showing a difference only of 0·06 second, which is to be equally distributed between the several values. The French determination, by telegraph, of Brest—Paris, made in 1863, is within 0·01 second the same as above, while that of Paris—Greenwich, made earlier, is 0·46 second less than the value now found. It is a singular combination of circumstances, which led to the correction of the longitude between the two principal observatories of Europe by American astronomers. For the longitude Harvard—Greenwich we have now three independent results, obtained in different years, by different observers, and through different cables; for in 1870 the two cables were joined at St. Pierre, and the signals exchanged directly between Brest and Duxbury, while in 1872 an intermediate station was made at St. Pierre, whence the signals were sent, *via* Sydney and the provinces, to Cambridge. The results are:—

Longitude Harvard Observatory from Greenwich Observatory.

	Hours.	Mins.	Secs.
1867	4	44	31·00
1870	4	44	31·05
1872	4	44	30·99
Mean	4	44	31·01

The close agreement of these results indicates a very near approximation to the truth, and this fundamental longitude may now be considered as settled. Adding to the above value the difference in time between the Washington and Harvard Observatories, 23 minutes 12·12 seconds, we get for Washington 5 hours 8 minutes, 12·12 seconds.

City and Commercial Notes.

A meeting of the English shareholders of the River Plate and Brazil Telegraph Company, Limited, was held on the 29th ult., at the Cannon-street Hotel, Mr. Albert Grant in the chair, for the purpose of considering the agreements entered into with a view to incorporating the cables of that Company with the system of cables from Europe to Brazil. The cables owned both by the River Plate and Brazil Company and the Montevidean and Brazilian Company will be handed over to the Western and Brazilian Company, who will thenceforth work and maintain them, incorporating them into their system, both to Europe and America, thus practically making these three companies one undertaking as regards the continuous line from Pará to the River Plate, the Western and Brazilian Company handing over for division between the River Plate and Brazil Company and the Montevidean and Brazilian Company 20 per cent of the gross receipts on the entire line from all sources from Pará to Montevideo. The division of this 20 per cent between the two latter Companies will be 85-100 to the River Plate and Brazil Company and 15-100 to the Montevidean and Brazilian Company. By this arrangement competition is avoided, which might otherwise have arisen through duplicate lines being laid from Rio de Janeiro to the River Plate. This will practically give a bonus equal to £5 per share to the holders of the River Plate and Brazil Company's shares; and a resolution was passed authorising the division of such shares, when received, in the proportion of one bonus share of £20 for every four shares held in the River Plate and Brazil Company. Authority was also taken to issue the remaining 5000 shares of the River Plate and Brazil Company, the shares to be offered, in the first instance, to the existing shareholders at par, in the proportion of one share for every share now held, such shares being entitled to the bonus above referred to. Resolutions were passed approving the agreements entered into by the Directors in carrying out the above arrangements with the various Companies, and a general feeling of satisfaction was expressed at the highly favourable position in which the River Plate and Brazil Company will now stand, and with the prospects of the undertaking.

The *Anglo-Brazilian Times* of the 22nd August, gives full details of the meeting of the Platino-Braziliera Telegraph Company at Rio, which resulted in the unanimous confirmation of the agreement under which the lines of that company are to be worked by the Western and Brazilian Telegraph Company, on condition of the Platino-Braziliera Company receiving one-fifth of the gross earnings of the united system. Major Rickard, as the representative of the English shareholders, pointed out the advantages to accrue to both companies from the proposed agreement, and a resolution was passed authorising an issue of £100,000 redeemable 7 per cent debentures to complete all remaining works, the paid-up share capital being £400,000.

The Montevidean and Brazilian Telegraph Company (Limited) have received a telegram announcing the successful laying of the section of cable between Montevideo and Maldonado on the 23rd of August.

The Australian Cable Company have offered to reduce their rates by one-half, on condition of receiving an annual subsidy of £30,000 from the Colonies.

Creditors of the Cape of Good Hope Telegraph Company (Limited), are required to send details of their claims to Mr. W. Quilter, the liquidator, within two months.

Cable investments have this satisfactory peculiarity—that events which proves disastrous to other undertakings bring nothing but benefit to them. We have reason to believe that the traffic receipts of the Atlantic Cables reached £3000 per day on Friday and Saturday last, and that the average of this month, including Sundays, has been about £2100 per day, or at the rate of about £765,000 a-year gross.—*Financier*, September 24th.

We regret to announce the death of Mr. George Saward, who was formerly the secretary of the first Atlantic Telegraph Company. Latterly, Mr. Saward has been secretary to the Submarine Cables' Trust.

The Eastern Extension, &c., Telegraph Company have received information of an interruption in their cable. The fault appears to be in shallow water close to Hong Kong, and it is believed that communication will be restored in the course of a few days, as soon as the ship can reach the site of the fault.

Reuter's Telegram Company announce that, "in consequence of the interruption of communication by

the Singapore and Hong Kong Cable, messages for China and Japan are forwarded by the Great Northern Telegraph lines, which are working well."

TELEGRAPH SHARE LIST.

Amount per Share.	Name of Company.	Amount paid up.	Closing Quotations.
£		£	Sep. 29.
Stock	Anglo-American (Limited)	100	87¼—88¼
10	Brazilian Submarine..	7	2—1¼ dis.
10	Cuba	All	9¼—9¾
10	Direct Spanish	9	⅛dis.—¼pm
20	Direct United States Cable	11	6—4 dis.
10	Eastern (Limited)	All	8¾—9
10	Ditto New	All	8⅞—8⅞
10	Eastern Extn. Australia and China	All	8⅝—8¾
10	Great Northern	All	9¼—10
25	Indo-European	All	15—17
10	Mediterranean Extension (Limited)	All	5—5¼
10	Do., 8 per cent Pref...	All	11—12
8	Reuters	All	10¾—11¼
Stock	Submarine	100	240—250
1	Do., Scrip	All	2¼—2¾
10	West India and Panama	All	6⅜—6¾
10	Do., 10 per cent Pref.	7½	½—1 pm.
20	Western and Brazilian (Limited) ..	18	7—5 dis.
1000 dls.	West Un. U.S. 7 per cent 1st M.B.	All	93—95
10	Hooper's Telegraph Works	All	11—12
50	India-Rubber and Gutta Percha ..	All	31—33
Cert.	Submarine Cables Trust	100	112—115
12	Telegraph Construction	All	32½—32⅝
100	Ditto Ditto 7 per cent Bonds	100	102—105

Patents.

251. Remy Elmsley, of Toronto, Canada, at present residing at Leamington, in the county of Warwick. *Improvements in Electric Communication between Railway Trains in Transit and Stations or Termini, and in the Apparatus connected therewith.* Dated January 22, 1873. The novelty of the invention consists in maintaining an electric contact between the trains or carriages whilst in transit on railways, and a wire communicating with stations and termini on the line, by means of an adjustable revolving grooved pulley or pullies running on such wire, and which are connected with a portion of the train by means of an adjustable metallic axle communicating with an electric apparatus in the guard's van.

332. Alex. Bernstein, of Berlin, in the Kingdom of Prussia, Engineer. *Self-acting Apparatus for Effecting Electric Contact by Passing Trains or Carriages on Rail or Tramways.* Dated January 28, 1873. The invention relates to the use of bars at the sides of the ordinary rails, in position to be acted upon by the wheels, such bars acting by a cross bar on a double spring carrying a plate capable on the depression of both bars of acting on an india-rubber bag to cause air to flow, and by bringing parts into connection effect by electrical communication an alarm or signal.

344. David Alexander Carr, and Crawford Peter Barlow, both of 2, Old Palace Yard, Westminster. *Improvements in Railway Electrical Signal Apparatus.* Dated January 28, 1873. The object effected by our invention is that no train passing along a line of railway can approach within a limited distance of the preceding train without receiving a warning signal. Along the line are places (either stations, junctions, or other places on the line) at which a signal can be transmitted electrically on to the engine or on to any carriage of a train by preference through insulated metal bars placed along the line in the manner described in the Specification of a former Patent granted to us on the 18th day of May, 1872 (No. 1520). In between these are other places, at which a train passing over a level or other mechanical or electrical apparatus causes the insulated bar at the station the train has just left to be uncoupled from a battery, so that any following train arriving at such station would receive a signal of line blocked, and at the same time causes the insulated bar at the preceding station to be coupled up to its battery, so that when a following train arrives at that station the line clear signal will be given to it.

441. William Robert Lake, of the firm of Haseltine, Lake, and Co., Patent Agents, Southampton Buildings, London (a communication from Messrs. Garau Ticozzi and Co., of Milan, Italy). *Improvements in Electrical Brakes for Railway Trains.* Dated February 6, 1873. The principal object of this invention is the construction of a brake which may be operated in case of danger either by the engine driver or the guard. The electrical mechanism occupies but little space. The said mechanism has two bobbins with coils of conducting wire whose extremities are fixed to the two poles of a battery. The circuit may be established or interrupted by means of a button placed within reach of the driver. To the frames of the said bobbins is fixed an armature. Above this part of the apparatus there is a drum which turns upon two pivots, and which carries a cord provided with a weight. When the apparatus is set the button is pressed, the electric circuit is closed, the bobbins are magnetised and attract the armature, which causes the hollow cylinder to turn on its pivots. The weight can then descend and turn the said drum, which through suitable bevel gearing closes the brakes.

Postal Telegraphy.—From a paper published by the authority of the Postmaster-General, the following extracts may be useful, interesting, and worthy of public perusal. Postal telegraph cards, with space for twenty words, are now issued at the cost of one shilling each. They are intended for inland messages only, and are delivered free within one mile from the terminal station. They may be posted like an ordinary letter in a pillar, wall, or post-office letter-box, whence they are carried away by the usual collector for transmission by wire. Now a large number of these boxes are cleared at three a.m., and a telegraph card deposited in one of them after the departure of the night mails or during the time the telegraph-office is closed—usually between eight p.m. and eight a.m.—would be taken out at three a.m. and sent off by wire, as soon as the business of the day commenced. Packets containing twenty of these cards may be purchased at £1 per packet. Books of inland telegraph forms, upon which a 1s. stamp is embossed, may also be had at the rate of £1 per 20 forms, and interleaved books with the name and address of the sender and receiver printed upon each form, are supplied free of extra cost if 500 are taken at a time. The cost of a reply to a telegram may be prepared, and the reply may be sent at any time within two months of the date of the original telegram, a prepaid reply form being delivered to the receiver, who may either use it for the reply, or to prepay another message.

PRIZES TO STUDENTS.

It has been decided to offer, from time to time, to our Students, prizes for the best and most carefully considered paper on a given subject. By the kindness and courtesy of Mr. Robert Sabine, C.E., who has placed the funds at our disposal, we are enabled to commence the series with a

PRIZE OF £25,

to be awarded to the Author of the best paper on "The Evidence of the Theory of Correlation of Physical Forces as applied to Electricity and Magnetism," received by the Editor of this Journal on or before January 1st, 1874. Each paper submitted for competition must describe original experiments. Each paper to bear (on every leaf) some word or motto by which it may be recognised. The same word or motto to be inscribed on a sealed envelope containing real name and address of competitor. The papers not selected will be destroyed with the envelopes unopened. Papers to be addressed to the Editor, and endorsed "Students' Prize." The best papers will be selected and submitted to a Committee of well-known Electrical Authorities (whose names will be published), who will award the prize for the most carefully prepared paper, irrespective of the view taken by its Author, whether favourable or unfavourable to the new theory. The award to be final. The Prize Paper to be printed in the columns of this Journal.